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(54)発明の名称　エレクトレット化高分子シート状物及びその製造方法

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明細書

1．発明の名称

エレクトレット化高分子シート状物及びその製造方法

2．特許請求の範囲

1　高分子シートの少なくとも片面の表面にシラン系化合物又はフッ素系化合物よりなる膜厚0.03～0.5μの架橋構造膜を有し、該薄膜がエレクトレット化していることを特徴とする高分子シート状物。

2　高分子シートの少なくとも片面の表面にプラズマ重合によりシラン系化合物又はフッ素系化合物を用いて架橋構造膜を形成させ、その膜厚を0.03～0.5μとし、その後直流の高電圧電源により該薄膜をエレクトレット化することを特徴とする高分子シート状物の製造方法。

3．発明の詳細な説明

（産業上の利用分野）

本発明は表面高電荷密度を有する高分子シート、特に高分子シートがポリエステルのフイルム又は織編物又は不織布である高分子シート状物に関する。

（従来の技術）

現在エレクトレット化品はマイクロホン、ヘッドホン、補聴器、拡声電話機など静電型電気音響トランスデューサーとしての応用が進んでいるが、エレクトレット化する膜厚を薄くできればそれだけ表面電荷密度が上り、エレクトレットの静電場を利用するにはより効果的である。またエレクトレットの他の大きな用途として、不織布等をエレクトレット化したフイルターが効率よく集じんできるということで注目をあびている。これらの用途のなかで、従来エレクトレット化しにくいもの、又はエレクトレット化してもその性能の持続性が悪いものをエレクトレット化したいという要望もある。例えばポリエステルのエレクトレット化などがこの例である。

（発明が解決しようとする課題）

即ち本発明の課題は、フイルム、織編物、不織

布等の高分子シート状物のエレクトレット化にあるが、特にその素材がポリエステルの場合にも表面電荷密度が著しく高くかつ持続性のあるエレクトレット化高分子シート状物を得んとするものである。

（課題を解決するための手段）

即ち、本発明は、

「1 高分子シートの少なくとも片面の表面にシラン系化合物又はフッ素系化合物よりなる膜厚0.03〜0.5μの架橋構造膜を有し、該薄膜がエレクトレット化していることを特徴とする高分子シート状物。

2 高分子シートの少なくとも片面の表面にプラズマ重合によりシラン系化合物又はフッ素系化合物を用いて架橋構造膜を形成させ、その膜厚を0.03〜0.5μとし、その後直流の高電圧電源により該薄膜をエレクトレット化することを特徴とする高分子シート状物の製造方法。」

に関する。

本発明で言う高分子シートとは、フイルム、織編物、不織布等のシート状物を言う。高分子には特に限定はなく、天然高分子、再生高分子、合成高分子等をさす。一般に最も汎用性に富むポリエステルはエレクトレット化しにくくその持続性も悪いことから本発明の手法はポリエステルには特に有効と考えられる。

本発明で言う少なくとも片面とは、高分子シートの一表面または両表面を言う。高分子シート表面には、電極などの目的として金属等の導電物質がコート、蒸着、スパッタリング、イオンプレーティング等で付着していてもよい。

本発明に使用するシラン系化合物又はフッ素系化合物モノマーについて説明する。

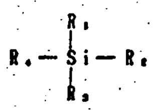
プラズマ重合法に使用されるフッ素系化合物モノマーとは、C_2F_4、C_3F_6で代表される$C_nH_mCl_pF_{2n-m-p}$タイプ（$n\geqq 0$、$m\geqq 0$、$p\geqq 0$、$2n-m-p\geqq 1$の整数）、CF_4、C_2F_6、C_3F_8で代表される$C_nH_mCl_pBr_qF_{2n+2-m-p-q}$タイプ（$n\geqq 1$、$m\geqq 0$、$p\geqq 0$、$q\geqq 0$、$2n+2-m-p-q\geqq 1$の整数）、$C_4F_8$で代表される$C_nH_mCl_pF_{2n-m-p}$の環状タイプ（$n\geqq 3$、$m\geqq 0$、$p\geqq 0$、$2n-m-p\geqq 1$の整数）、$C_4F_6$で代表される$C_nH_mCl_pF_{2n-2-m-p}$の二重結合を有する環状タイプ（$n\geqq 4$、$m\geqq 0$、$p\geqq 0$、$2n-2-m-p\geqq 1$の整数）、$C_3F_6O$で代表されるタイプ、$NF_3$、$SF_6$、$WF_6$で代表されるタイプ等、各種のものが存在する。

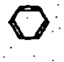
これらの中で成膜速度が大きく工業的に好ましいものとしてはC_2F_4、C_3F_6、C_3F_8、C_4F_8、C_3F_6O、$C_2H_2F_4$等であるが、運搬上の安全性、成膜速度などからさらに好ましくは、C_3F_6、C_4F_8、C_3F_6Oである。

またこれらのフッ素系化合物の中には単独では成膜能力の低い物も、少量の水素ガスまたは非重合性ガスと混合してプラズマ重合させると成膜速度の著しく向上するものがある。水素ガスとの混合で成膜速度が著しく向上するものとして、CF_4、C_2F_6、C_3F_8、$C_2H_2F_4$が代表的であり、非重合性ガスと混合して成膜速度が向上するものとして、C_2F_4、C_3F_6、C_4F_8、C_3F_6O等が代表的である。

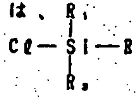
非重合性ガスの内効果の大きいのは不活性ガス類であり、アルゴンガスは特に効果的である。フッ素系化合物は、水素、塩素、臭素等の原子を含んでもさしつかえない。

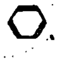
また本発明で使用するケイ素系化合物モノマーとは、



$R_4-\overset{\displaystyle R_1}{\underset{\displaystyle R_3}{Si}}-R_2$ （但しR₁〜R₄は、OCH_3、OC_2H_5、CH_3、C_2H_5、$CH_2=CH$、H、、のいずれか）で表わされるアルコキシシラン系ケイ素化合物、

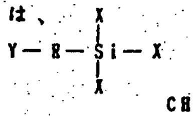
または、



$Cl-\overset{\displaystyle R_1}{\underset{\displaystyle R_3}{Si}}-R_2$ （但しR₁〜R₃はH、CH_3、$CH_2=CH$ 、Cl、$ClCH_2$のいずれか）

で表わされるクロロシラン系化合物、

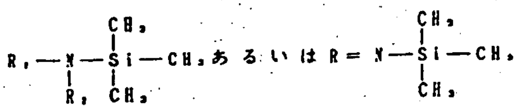
または、



$Y-R-\overset{\displaystyle X}{\underset{\displaystyle X}{Si}}-X$ （但しYは$CH_2=CH$、CH_2-CHCH_2O、NH_2、SH、Cl、$\underset{\displaystyle O}{\overset{\|}{C}}-CH_3$ $NHR'NH_2$（R'：アルキル基）のいずれか、Rはアルキル基、XはOCH_3、 OC$_2$H$_5$のいずれか）

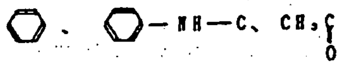
で表わされるシランカップリング系ケイ素化合物、

または



$R_1-\underset{R_2}{N}-\overset{CH_3}{\underset{CH_3}{Si}}-CH_3$ あるいは $R=N-\overset{CH_3}{\underset{CH_3}{Si}}-CH_3$

（但しR$_1$〜R$_2$はH、CH$_3$、C$_2$H$_5$、Si(CH$_3$)$_3$、

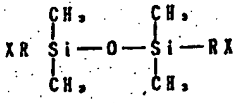


—NH—C、$CH_3\underset{O}{C}$のいずれか、

RはCH$_3$COSi(CH$_3$)$_3$、CF$_3$COSi(CH$_3$)$_3$のいずれか）

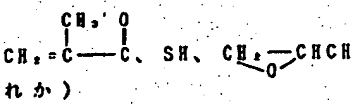
であるシラザン系ケイ素化合物、

または



$XR\,\overset{CH_3}{\underset{CH_3}{Si}}-O-\overset{CH_3}{\underset{CH_3}{Si}}-RX$

（但しRはアルキル基、XはCℓ、NH$_2$、



$CH_2=\overset{CH_3}{C}-\overset{O}{C}$、SH、$\underset{O}{CH_2-CH}CH_2O$のいずれか）

である反応性シロキサンオリゴマー系ケイ素化合物、を言う。代表的なものに、トリメトキシシラン、トリメトキシビニルシラン、トリエトキシシラン、トリエトキシビニルシラン、トリメトキシクロルシラン、トリメチルメトキシシラン、ジメトキシビニルシラン、ジメチルメトキシビニルシラン、トリメチルビニルシラン、トリエチルビニルシラン、ビニルトリフロロシラン、ヘキサメチルジシラザン、ジメチルトリメチルシリルアミン、アミノシロキサン、クロロシロキサン、等がある。

ケイ素化合物をプラズマ装置内に供給する場合、キャリアーガスとしてアルゴンチッ素等の不活性ガスと混合して使用してもさしつかえないし、さらに緻密な膜を形成させるために酸素等と混合してもよい。

本発明で言うプラズマ重合とは、低温プラズマ放電を利用した重合法をいい、放電時に重合法モノマーを1種以上供給しながら重合膜を形成させる方法を言う。

低温プラズマとは、放電中に生成されるプラズマが平均電子エネルギー10eV（10^4〜10^{5}K）、電子密度10^9〜10^{12}cm^{-3}で特徴づけられると同時に、電子温度とガス温度との間に平衡が成立しない故に非平衡プラズマとも言われる。

プラズマ重合を行う装置としては特に制約がなく、連続式、バッチ式、内部電極式、外部電極式いずれでも良い。

通常放電時の真空度は0.01〜0.5Torr程度に保たれ、出力は0.1w/cm^2〜5w/cm^{2}程度である。処理時間は数秒〜数分が一般的であり、膜厚を0.03〜0.5μ程度にすることが望ましい。膜厚が0.03μ以下だとエレクトレット効果が少なく、膜厚が0.5μをこえると膜自体が硬くもろくなる傾向にあり望ましくない。

膜厚の測定はスライドガラス上にカバーグラスをおいたものを、プラズマ処理装置のサンプルをセットした電極上におき、プラズマ、重合後カバーグラスを除去し、スライドグラスにできた段差を干渉顕微鏡により測定する。

エレクトレット化はプラズマ薄膜をエレクトレット化するものであり、高分子シートの両面にプラズマ薄膜が存在する場合は、両面を同極性にエレクトレット化しても、異極性にエレクトレット化してもよく、さらに一面のみをエレクトレット化してもよい。また高分子シートの一表面のみにプラズマ薄膜が存在する場合はその薄膜をエレクトレット化する。

エレクトレット化する装置は通常のもので良い。すなわち数十kvの高電圧を発生させる直流電源と、試料が接触するロール状電極（通状アースされる）と対電極（針状電極）よりなる装置で行われる。エレクトレット化の効率を上げるためにロールは加熱できるようになっているものが良い。また簡便タイプとして、コロナ放電が行われる装置でもよい。

エレクトレットの程度は、被処理物と電圧、処理速度、電極間距離、ロール温度により任意に選択できるが、高電圧をかけすぎると、シートが破れたり溶融したりするので注意が必要である。エレクトレット化の程度としては、表面電荷密度として1×10^{-10}c/cm^{2}以上好ましくは3×10^{-10}c/cm^{2}が好ましい。

表面電荷密度の測定は第1図の方法により行なった。試料1をアースした金属板2上に置き、他の

金属電極板（4cm径）3を上方から試料1に接触させて、試料電荷を金属電極板3に誘導させて、それを既知コンデンサー4にためて、コンデンサー4の電位を電位計5で測定する。

表面電荷密度（c/cm^2）＝C×V×S

C：コンデンサー容量（ファラッド）

V：電圧（ボルト）

S：金属電極板面積（cm^2）

以下実施例にしたがつて説明する。

実施例1

ポリエチレンテレフタレートからなる2軸延伸フイルム（厚さ10μ）の両面にC_2F_4モノマー30CC/分の流量で真空度0.3Torr出力0.177W/cm^{2}で120秒間プラズマ重合処理を行ない、膜厚0.15μの架橋された薄膜を形成させた。

高周波電源：13.56MHz

電極　　　：平行平板電極

このシートの片面に、50KVの直流電源により⊕の電荷をもたせた。

電極間距離　5cm

シートが接する側の電極温度　120℃

処理時間　5秒

印加電圧　30KV

次にフイルムを裏返しにし同様の要領で⊖の電荷を持たせるように電源部を一部調整しエレクトレット化した。

比較例としてプラズマ重合処理してないポリエチレンテレフタレートフイルムを同様に裏表エレクトレット化した。

プラズマ重合薄膜を有するフイルムの表面電荷密度は⊕7×10^{-8}c/cm^2、⊖6.5×10^{-8}c/cm^{2}であり、プラズマ重合処理していないフイルムの表面電荷密度は⊕5×10^{-11}c/cm^2、⊖4×10^{-11}c/cm^{2}であつた。

プラズマ重合薄膜のエレクトレット化維持性を調べるために、100℃の雰囲気中に100時間入れておいた後表面電荷密度を測定したが、⊕6.7×10^{-8}c/cm^2、⊖6.4×10^{-8}c/cm^{2}と初期性能を維持していた。

実施例2

ポリエチレンテレフタレートの50デニール98フイラメントよりなる延伸糸をタテ糸、ヨコ糸に用い高密度タフタ織物を織つた。この織物を糊抜き－精練－プリセット（180℃1分間）－染色－仕上と従来の工程を通した。

この織物をビニルトリメトキシシランモノマーによりプラズマ重合薄膜を一表面に施こした。

プラズマ重合条件、装置は実施例1と同様のものを使用した。この時の膜厚は0.12μであつた。

この織物を実施例1と同様の条件でエレクトレット化した。エレクトレット化とはプラズマ重合表面のみとし、⊕の電荷をもたせた。

この織物を使用し、防塵衣を作成した。エレクトレット化した面が外側（体にさわらない面）になるように服を作つた。対照にプラズマ重合処理をしていない織物を使い同様にエレクトレット化防塵衣を作成した。

これらの服を着て1時間デスクワークをした時の体からの発塵量をはだかで行なつた場合と比較して調べた。発じん量は、はだかでデスクワークした時を100とすると、プラズマ重合処理せずにエレクトレット化した服を着用した場合が10、プラズマ重合処理してエレクトレット化した服を着用した場合が2、と著しくからだからの発塵量をおさえることができた。

4．図面の簡単な説明

第1図は表面電荷密度の測定を行なうための説明図である。

特許出願人　株式会社　クラレ
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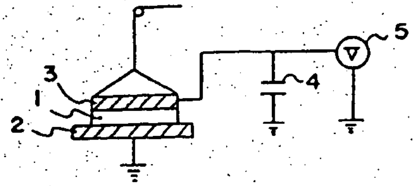
第 1 図



1 : 試料
2,3 : 金属板
4 : コンデンサー
5 : 電位計

(19) Patent Office of Japan (JP) (11) Publication of Patent Application

(51) JAPANESE PATENT APPLICATION (KOKAI)(A)

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(51) Int. CL. 5 ID Code Office Cont'l No. (43) Publication: Hei-Sei 1 (1988) 9/18

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27/30		D-	8115-4F

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Number of claims of the invention: 2

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(54) Name of the invention: Electretized Polymer Sheet Type Material and Its Manufacturing Method

(21) Filed Number: Application Showa 63-58805

(22) Filed Date: Showa 63 (1988) 3/11

(71) Patent Assignee: Kurare Company

JP 1-232038

[Note: Names, addresses, company names and brand names are translated in the most common manner. Japanese language does not have singular or plural words unless otherwise specified by a numeral prefix or a general form of plurality suffix.]

Description of the Invention

1. Name of the Invention

Electretized Polymer Sheet Type Material and Its Manufacturing Method

2. Scope of the Claims

1) Polymer sheet type material where at the surface of at least side of the polymer sheet there is a crosslinked structure possessing layer which has a layer thickness in the range of 0.03 ~ 0.5 microns and which is formed from a silane type compound or a fluorine type compound; and where the above conductive layer has been electretized.
2) Manufacturing method for the preparation of polymer sheet type material, characterized by the fact that at the surface of at least side of the polymer sheet a crosslinked structure possessing layer is formed by using a silane type compound or a fluorine type compound through plasma polymerization, and its layer thickness is made to be in the range of 0.03 ~ 0.5 microns, and where after that the above conductive layer has been electretized by a direct current high voltage electrical source.

3. Detailed Explanation of the Invention

(Technological Sphere of Application)

The present invention is an invention about a polymer sheet type material that has a high electrical density surface, and especially it is an invention about a polymer sheet type material where the polymer sheet material is a polyester film or woven material or nonwoven fabric material.

[Prior Art]

At the present time the application of electretized products as microphones, headphones, hearing aid, speakerphones etc., electrostatic type electrical sound transducers, has progressed. However, the electrical charge density of the sheet can be increased only by making the thickness of the electretized layer as thin as possible, and then this is effective as the electrostatic field of the electret is advantageously used. Also, as another large application of the electrets, the application where filters, obtained as nonwoven fabric material etc., is electretized, have good collection efficiency, has attracted the attention. In these applications, it is also required that materials that have been difficult to electretize in the past, or materials which even when there have been electretized have poor properties with respect to sustaining that performance, be electretized. For example, this is the case of the electretization of polyester etc.

(Problem Solved by the Present Invention)

Namely, the topic of the present invention is the electretization of film, woven fabric material, nonwoven fabric material etc., polymer sheet type material. And especially the topic of the present invention is that even in the case when its material is a polyester material, an electretized polymer sheet type material be obtained where the surface electrical charge density is significantly increased and also, where the sustaining properties of this performance are present.

(Measures in Order to Solve the Problem)

Namely, the present invention is an invention about a,

"

1) Polymer sheet type material where at the surface of at least side of the polymer sheet there is a crosslinked structure possessing layer which has a layer thickness in the range of 0.03 ~ 0.5 microns and which is formed from a silane type compound or a fluorine type compound; and where the above conductive layer has been electretized.

2) Manufacturing method for the preparation of polymer sheet type material, characterized by the fact that at the surface of at least side of the polymer sheet a crosslinked structure possessing layer is formed by using a silane type compound or a fluorine type compound through plasma polymerization, and its layer thickness is made to be in the range of 0.03 ~ 0.5 microns, and where after that the above conductive layer has been electretized by a direct current high voltage electrical source."

The term "Polymer sheet" used according to the present invention includes film, woven material, nonwoven fabric etc., sheet type material. There are no particular limitations regarding the polymer material used according to this invention and natural polymer materials, regenerated polymer materials, synthetic polymer materials are included. The usually mostly widely used polyester is a material that is difficult to electretize and whose electretization sustaining properties are poor, and because of that the method according to the present invention is considered to be especially effective for the polyester materials.

Regarding the statement used according to the present invention "at least on one side", it indicates on one surface or on both surfaces of the polymer sheet material. It is also a good option if metal etc., thin electroconductive materials are adsorbed on the surface of the polymer sheet by using coating, vapor deposition, sputtering, ion plating etc., method, in order to obtain electrodes etc.

An explanation will be provided regarding the silane type compounds or fluorine type compounds that are used according to the present invention.

As the fluorine type compounds that are used in the plasma polymerization method, there are different compounds present as the following here below materials (the numbers in the formulae are best guess – almost illegible – translator's note): CnHmClpF2n-m-p type compounds (n>= 0, m>= 0, p>= 0, 2n-m-p >= 1 integer number), represented by C2F4, C3F6, CnHmClpBrq F2n+2-m-p-q type compounds (n>= 1, m>= 0, p>= 0, q>= 0, 2n+2-m-p-q >= 1 integer number), represented by CF4, C2F6, C3F6, CnHmClpBrq F2n-m-p cyclic type compounds (n>= 3, m>= 0, p>= 0, q>= 0, 2n-m-p >= 1 integer number), represented by C4F3, CnHmClpBrq F2n-2-m-p double bond containing cyclic type compounds (n>= 4, m>= 0, p>= 0, q>= 0, 2n-2-m-p

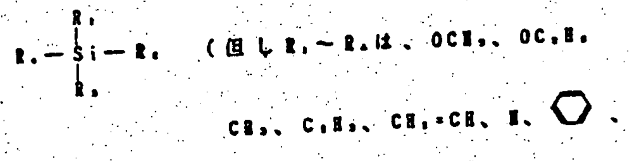
>= 1 integer number), represented by C4F6, type of compounds represented by C3F6O, type of compounds represented by NF3, SF3, ..F:.(illegible), etc.

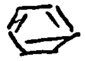
Among these, the materials that are preferred operationally because of their fast rate of layer formation are C2F4, C3F6, C3F8, C4F8, C3F6O, C2H4F2 etc., however, from the point of view of the safety properties of transportation, layer formation speed etc., then, the preferred materials are C2F6, C3F4, C3F2O.

Also, even regarding the materials, among these fluorine-containing compounds, which have a low layer-forming capability individually, they are materials for which if mixed with a small amount of hydrogen gas, or a non-polymerizable gas, and then plasma polymerized, the layer formation speed is significantly increased. As the materials where the speed of the layer formation is significantly increased by mixing with hydrogen gas, CF4, C2F6, C3F8, C2H4F2 are representative materials, and as materials where the speed of the layer formation is increased by mixing with non-polymerizable gas, C2F4, F3F6, C4F8, C3F6O, etc., are representative materials.

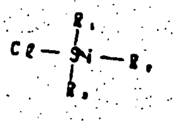
The significant inner effect of the non-polymerizable gas is the fact that it is a non-reactive gas, and argon gas is especially effective. And there is no problem if the fluorine containing materials contain hydrogen, chlorine, bromine etc., atoms.

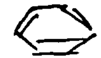
Also, as ~~the~~ monomers of the silicon type compounds that are used according to the present invention, alkoxysilane type silicon type compounds represented by:


$R-\underset{R}{\overset{R}{Si}}-R$

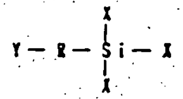
(where, R1 ~ R4, represents either of OCH3, OC2H5, CH3, C2H5, CH2=CH, );

or cholorosilane type compounds that are represented by:


$Cl-\underset{R}{\overset{R}{Si}}-R$

(where R1 ~ R3, represent either of H, CH3, CH2=CH,  , Cl, ClCH2);

or silane coupling type silicon type compounds represented by:

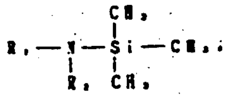


$$Y-R-\underset{X}{\overset{X}{Si}}-X$$

(where Y represents either of CH2=CH, CH2-CHCH2O, NH2, SH, Cl, $\underset{\underset{O}{\|}}{\mathrm{C}}\text{-}\mathrm{CH_3}$

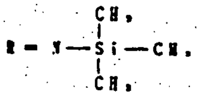
NHR'NH2 (R': alkyl radical), R represents an alkyl radical, X represents OCH3; OC_2H_5)

Or, silazane type silicon type compounds represented by the formula:

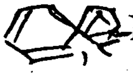


$$R_1-\underset{R_2}{N}-\underset{CH_3}{\overset{CH_3}{Si}}-CH_3$$

Or

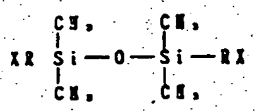


$$R=N-\underset{CH_3}{\overset{CH_3}{Si}}-CH_3$$

(where R1~R2 represents either of H, CH3, C2H3, Si (CH3)3, NH-C, $\underset{\underset{O}{\|}}{\mathrm{CH_3C}}$)

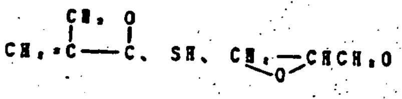
And R represents CH3COSi(CH3)3, CF3CoSi(CH3)3);

Or, reactive siloxane oligomer type silicon type compounds represented by



$$XR\ \underset{CH_3}{\overset{CH_3}{Si}}-O-\underset{CH_3}{\overset{CH_3}{Si}}-RX$$

(where, R represents an alkyl radical, X represents either of Cl, NH2,



As representative compound materials there are the following: trimethoxysilane, trimethoxyvinylsilane, triethoxysilane, triethoxyvinylsilane, trimethoxycholorosilane, trimethylmethoxysilane, dimethoxyvinylsilane, dimethylmethoxyvinylsilane, trimethylvinylsilane, triethylvinyl silane, vinyltrifluoro silane, hexamethyl disilazane, dimethyltrimethyl silyl amine, aminosiloxane, chlorosiloxane, etc.

In the case, when the silicon type compound is introduced inside the plasma equipment, there is also no problem if it is mixed with argon, nitrogen etc., inert gas used as a carrier gas. And then, it is also a good option to mix with oxygen etc. in order to form a dense layer.

The "plasma polymerization" term used according to the present invention is said to be a polymerization method that advantageously uses low temperature plasma electrical discharge, and it is a method, as the one or more types of the polymerizable monomers are being introduced at the time of the electrical discharge, a polymer layer is formed.

As the low temperature plasma it is also called a random, non-equilibrium plasma, such that the plasma which is generated during the electrical discharge has an average electron energy - 10eV ($10^4 \sim 10^5$ K) and at an electron density in the range of $10^{\cdots} \sim 10^{\cdots\text{(illegible)}}$ and at the same time, there is no equilibrium achieved between the electron temperature and the gas temperature.

There are no particular limitations regarding the equipment whereby the plasma polymerization is conducted, and it is a good option if any of the following types of equipment is used: continuous type, a batch type, an inner part electrode type, outer part electrode type.

Usually, at the time of the electrical discharge the degree of vacuum is maintained so that it is in the range of 0.01 ~ 0.5 Torr, and the output is at the level which is in the range of 0.1 w/cm2 ~ 5 w/cm2. The treatment time is usually in the range of several seconds to several minutes, and it is preferred that the layer thickness be within the range of 0.03 ~ 0.5 microns. In the case when the layer thickness is less than 0.03 microns, the electretization effect is small, and in the case when the layer thickness exceeds 0.5 microns, there is a trend that the layer itself becomes hard and it is not a preferred option.

The measurement of the layer thickness is conducted as a slide glass covered with a cover glass is placed on the electrode where the plasma equipment treated sample has been set, and after the plasma polymerization, the cover glass is removed, and the stepwise difference that is found on the glass slide is measured by an interference microscope.

Regarding the electretization, it is a phenomenon where a thin plasma layer is electretized, and in the case when a thin plasma layer is present on both sides of the polymer sheet, it is a good option if both sides are electretized at the same polarity, and it is also a good option if they are electretized at different polarities, and then, it is also a good option if only one surface side is electretized. Also, in the case when a thin plasma layer is present only on one side of the polymer sheet, this thin layer is then electretized.

Regarding the electretization equipment it is a good option if it is the usually used equipment. And namely, the electretization is conducted by equipment that is comprised of a direct electrical current source which generates several tens kV high electrical voltage, and a roll shaped electrode which comes in contact with the experimental material (and which is continuously grounded) and a counter electrode (needle shaped electrode).

It is also a good option if in order to increase the effectiveness of the electretization the roll can be heated. Also, it can be a simple use type equipment or it is also a good option if it is an equipment which conducts a corona electrical discharge.

Regarding the degree of the electretization, it can be freely selected depending on the material that is subjected to the treatment and the electrical voltage, the treatment speed, the distance between the electrodes, the roll temperature. However when the electrical voltage is too high it is necessary to pay attention that the sheet does not break or melt. As the electretization level, an electretization level that is 1 x 10 –10 c/cm2 or higher, expressed as surface electrical charge density, and preferably, 3 x 10 –10 cm/cm2, is used.

The measurement of the surface electrical charge density was conducted according to the method presented in Figure 1. The experimental material 1 is placed on the top the grounded metal plate 2, and another metal electrode plate (4 cm diameter) 3, is contacted with the experimental material from the upper side, and the electrical charge of the experimental material is directed and transferred towards the metal electrode plate 3 and it is accumulated in the previously known condenser 4, and then the measurement is conducted as the electrical potential of the condenser 4 is measured by the electrical potentiometer 5.

Surface electrical charge density (c/cm2) = C x V x S

C: condenser capacity (Farads)
V: Electrical voltage (Volts)
S: Surface area of the metal electrode

Here below, practical implementation examples are shown and by that the present invention is explained.

Practical Example 1

On both sides of biaxially oriented polyethylene terephthalate film (thickness 10 microns), a plasma treatment was conducted for a period of 120 seconds under a flow of 30 cc/minute of C2F4 monomer, and at a vacuum of 0.3 Torr, and an output of 0.1 .../cm3 (illegible), and by that a thin crosslinked layer was formed with a layer thickness of 0.15 microns.

High frequency electrical source: 13.56 Hz
Electrodes: parallel, flat plate electrodes

On one surface side of this sheet, a + electrical charge was placed by using 50 KV direct electrical current source.

Distance between the electrodes: 5 cm
Temperature of the electrode at the side which is in contact with the sheet
Treatment time: 5 seconds
Applied electrical voltage: 30 KV

After that the film is turned back and by using the same elements part of the electrical source is partially adjusted so that a – electrical charge is acquired, and by that the film was electretized.

The surface electrical charge density of the film that has the thin plasma polymerization layer was + 7 x 10 –9 c/cm, and – 6.5 x 10 –9 c/cm2, and the surface electrical charge density of the film that has not been subjected to the plasma treatment was 5 x 10 –11 c/cm2, and – 4 x 10 –11 c/cm2.

In order to evaluate the electretization maintenance properties of the plasma polymerized thin layer, the material was placed inside a 100oC ambient environment for a period of 100 hours and then after that the surface electrical charge density was measured. And the measurements showed a + 6.7 x 10 –9 c/cm2, and – 6.4 x 10 –9 c/cm2, and this indicated that the initial performance was maintained.

Practical Example 2

Oriented (elongated) fiber obtained from polyethylene terephthalate 50 denier 96 filament, was used as the longitudinal and the cross thread and a high density tufted fabric material was woven. This woven material was subjected to the same technological operations as those in the previous technology – it was pulled- bound and free set (180oC, 1 minute) – dyed, and finished.

On the surface of this woven material a plasma polymerization thin layer was formed by employing vinyl trimethoxy silane monomer material.

For the plasma polymerization conditions and equipment the same as those described according to the above Practical Example 1, were used. This time the layer thickness was 0.12 microns.

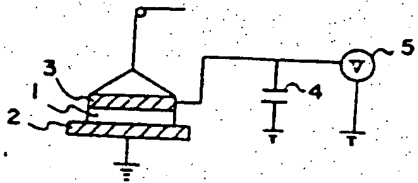
This woven type material was electretized under the same conditions as those described according to the above Practical Example 1. The electretization was conducted only on the plasma polymerization surface and a + electrical charge was imparted.

This woven material was used and wear protective clothing was produced. The clothing was made so that the electretized surface became the outer surface (the surface that is not against the body). For a comparison, the same electretized wear protection clothing was produced by using woven material that has not been subjected to the plasma polymerization treatment.

This clothing was put on and desk work was performed for a period of 1 hour and after that the amount of the wear generated in that case was compared to the case when the clothing was not worn. Regarding the amount of the generated wear, it was set as 100 when desk work was done not wearing the clothing, and in the case when the clothing was put on, which has been electretized without having been subjected to a plasma polymerization treatment, it was 10, and in the case when clothing was put on which has been subjected to plasma polymerization and then electretized, it was 2, and it is seen that the amount of the generated wear was significantly suppressed.

4. Simple Explanation of the Figures

Figure 1 is an explanation diagram in order to explain how the measurement of the surface electrical charge is conducted.



In the Figure:
1.......................Experimental Material
2,3....................Metal Plate
4.......................Condenser
5.......................Electrical Potentiometer

Patent Assignee: Kurare Company